Dust as a Working Fluid for Heat Transfer

Completed Technology Project (2013 - 2014)

Project Introduction

The project known as "Dust as a Working Fluid" demonstrates the feasibility of a dust-based system for transferring heat radiatively into space for those space applications requiring higher efficiency, lower mass, and the need to operate in extreme vacuum and thermal environments – including operating in low or zero gravity conditions in which the dust can be conveyed much more easily than on Earth.

Researchers (outside of NASA) have investigated the use of granular materials (e.g., mineral dust particles) as a working fluid for solar concentrators and other heat transfer systems. A given volume of dust particles have a higher heat capacity than the same volume of any gas, and mineral granular materials do not easily undergo a phase change like liquids except at extremely high temperatures. Granular materials also provide a medium for integrated energy storage.

The radiative transfer of heat directly into space using mineral dust particles is a new, revolutionary concept for NASA and for spaceflight in general. Space applications require high efficiency, low mass, and the ability to operate in extreme environments – including low or zero gravity where dust can be conveyed much more easily than on Earth. This project demonstrates the feasibility of dust-based heat transfer systems for space applications, but also has terrestrial applications. The project demonstrates and quantifies the radiative heat transfer efficiency by using a closed-loop, pneumatic regolith conveyance system in a laboratory experiment to test the critical function, thus achieving TRL 3.

Anticipated Benefits

This technology benefits the In-Situ Resource Utilization (ISRU) program within NASA and the US Department of Energy and Department of Defense. The utilization of mineral dust particles for heat transfer and energy storage for space applications will allow lower temperatures for low mass radiators on the cold end, while permitting extremely high efficiency power systems at extremely low mass. Hot dust that forms the "waste" material from an ISRU chemical reactor, can be stored in a tank or piled up as a solid with no containment pressure, and can be conveyed later as a granular fluid for on-demand heat recovery. Because of its extremely low thermal conductivity, a pile of dust self-insulates to preserve its thermal energy, thus also making it an efficient energy storage medium. The thermal properties of dust will enable in-space heat transfer system applications that require vastly reduced mass, while also enabling higher efficiency ground-based and surface-based systems.

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Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Kennedy Space Center (KSC)

Responsible Program:

Center Independent Research & Development: KSC IRAD

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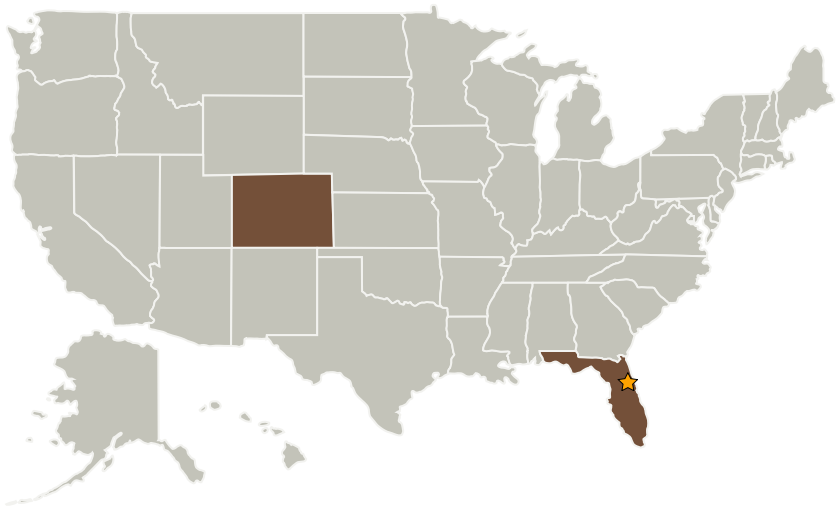
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Kennedy Space Center(KSC)	Lead Organization	NASA Center	Kennedy Space Center, Florida
QinetiQ North America(QNA)	Supporting Organization	Industry	
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
Colorado	Florida

Links

KSC-13971
(no url provided)

Project Management

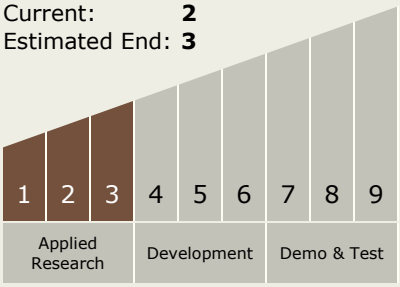
Program Manager:
Barbara L Brown

Project Managers:
Philip T Metzger
Robert P Mueller

Principal Investigator:
James G Mantovani

Technology Maturity (TRL)

Start: **1**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX07 Exploration Destination Systems
  - TX07.2 Mission Infrastructure, Sustainability, and Supportability
    - TX07.2.5 Particulate Contamination Prevention and Mitigation